AOI Watcher

User's Manual

	name function company	date signature
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1 PURPOSE

VTAOIWatcher enables users an easy access to a list of automatically updated and processed images acquired over "**monitored areas**".

User has to specify the attributes of each monitored area by setting:

- the "area of interest" (AOI),
- the desired "acquisition period",
- what type of images would be useful defining the "mission / instrument / mode(s)" (MIM),
- how the images should be processed through a "processing sequence" and
- the expected "minimum overlay" between the candidate images and the AOI.

Once the attributes of a monitored area have been set, VTAOIWatcher will look for existing data defined by the monitored area acting as a request and will regularly check if new images fit in the criteria (see fig. 1). Every image found is then imported in the "local archive", processed according to the user's requirements, prepared for efficient visualisation and the output products are stored in dedicated directories.

When VTAOIWatcher's users wish to access the processed data on a monitored area, it is ready and available for download using local network, hence, it is independant of the data provider's server state and bandwidth.

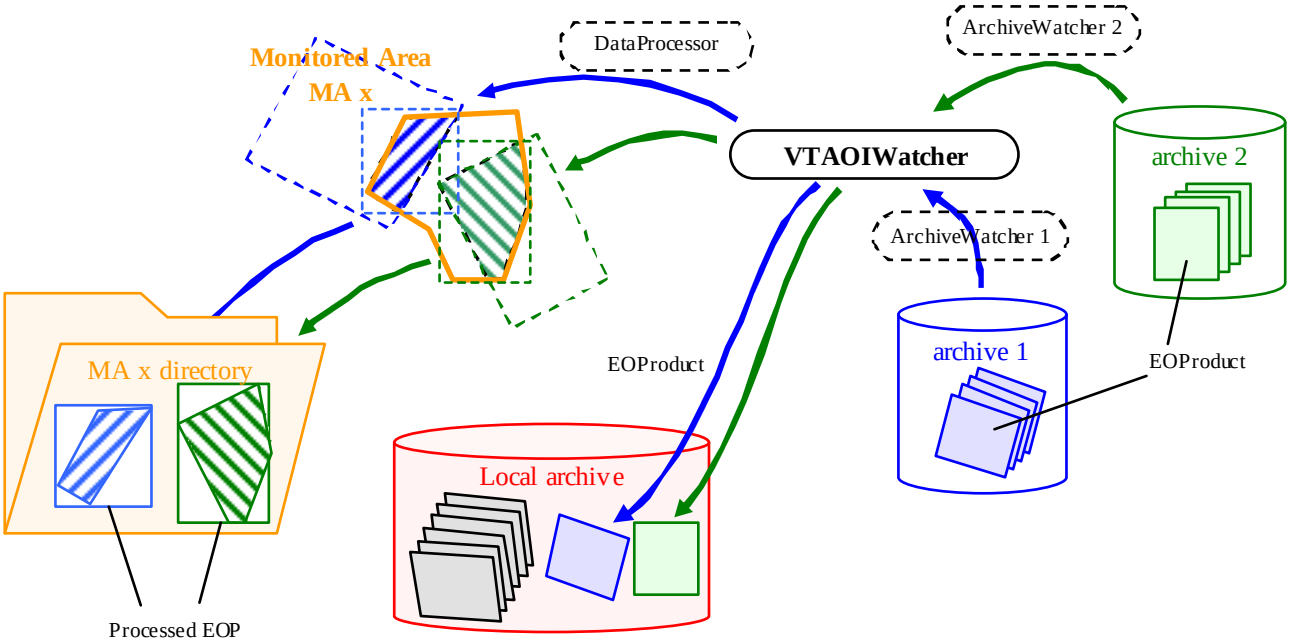

fig. 1 - Global view of VTAOIWatcher mechanism.

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2 MANAGING MONITORED AREAS

VTAOIWatcher is installed on a machine used as a server. All the functionnalities described in this user guide are accessible from this interface available using a recent Web-browser (like Internet Explorer, Mozilla Firefox…) at the address http://hostname/VTAOIWatcher/ where "hostname" is the name of the machine hosting the VTAOIWatcher software.

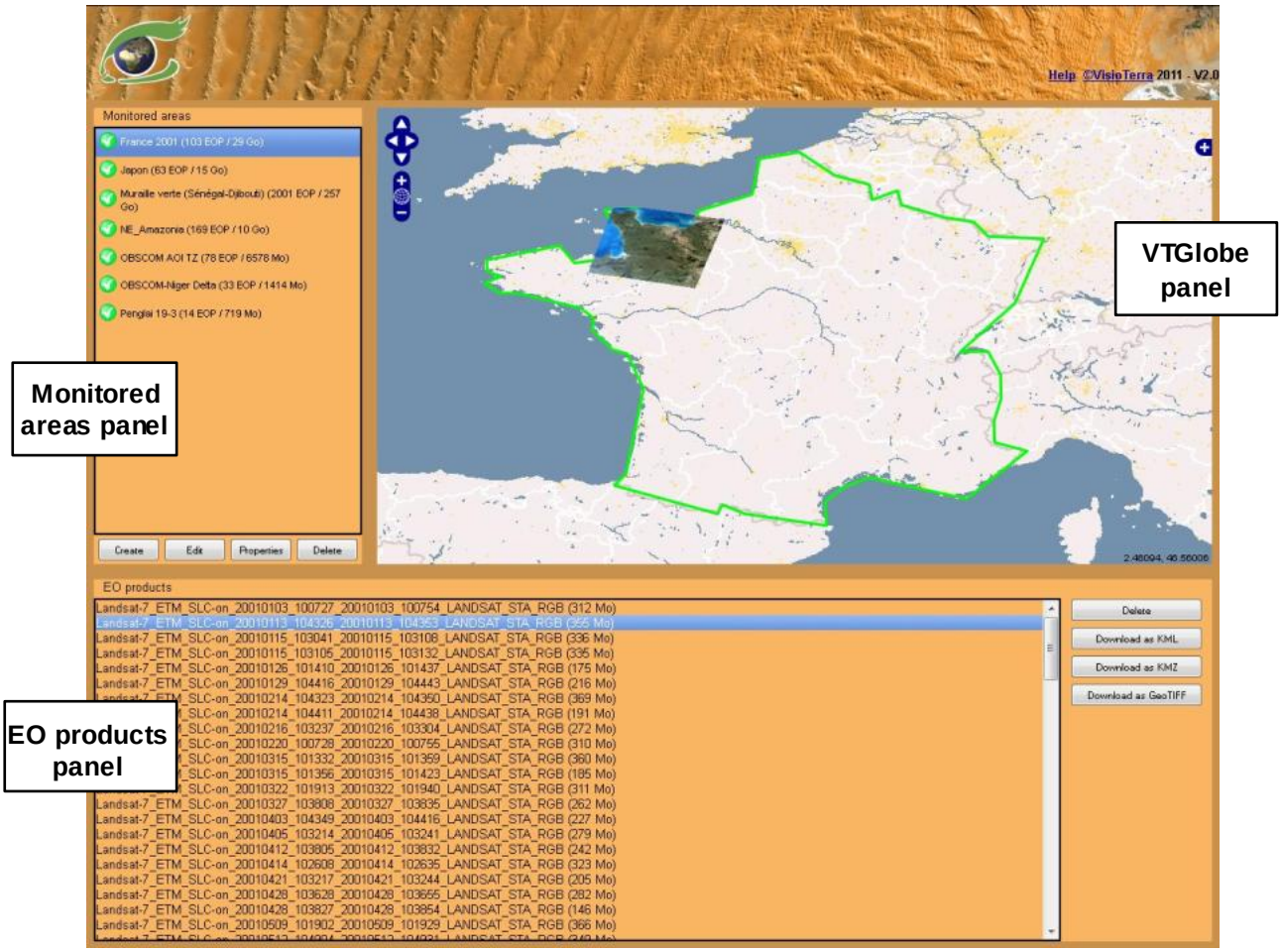

fig. 2- Panels constituting the VTAOIWatcher main interface.

2.1 Creating a monitored area

VTAOIWatcher has to find images matching the user's requirements. To this intent, attributes of any monitored area have to be specified. They define the different parameters that have to be taken into account to narrow the query when VTAOIWatcher questions a data provider database.

A monitored area is similar to a search query on all available data servers. Its results match the AOI ("where" question), the monitoring period ("when" question), the Mission-Instrument-Mode ("what" question) and the processing sequence ("how" question). The monitored area is also given a minimum overlay threshold (matching a pertinence threshold on results), a name (query's name) and a status (query's update status).

Clicking the "Create" button in the monitored area panel opens the monitored area creation panel.

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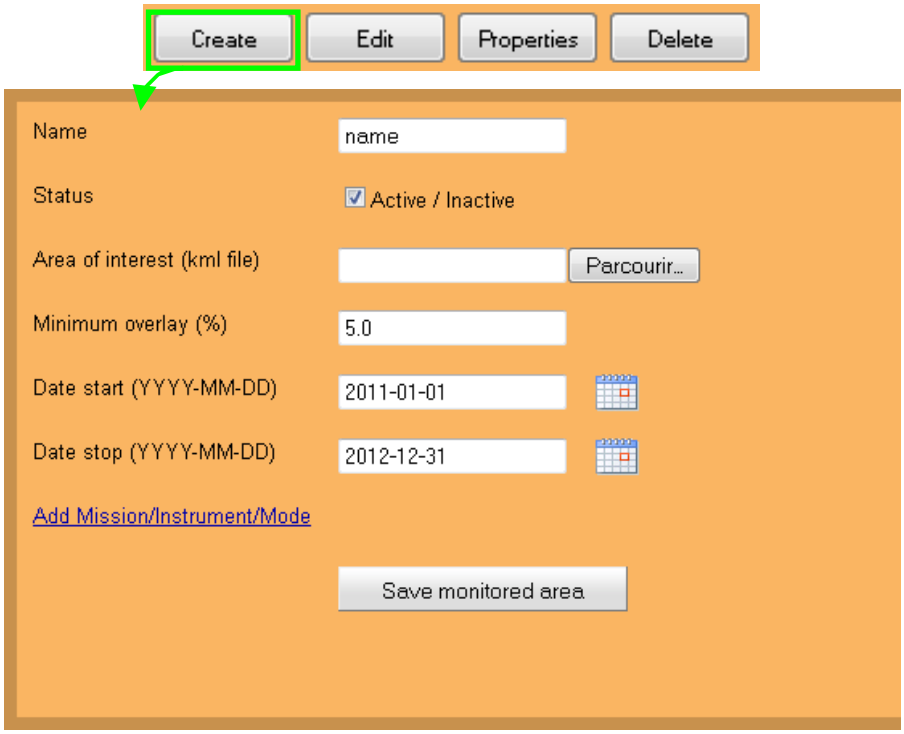


fig. 3- Monitored area creation panel.

2.1.1 Setting the AOI

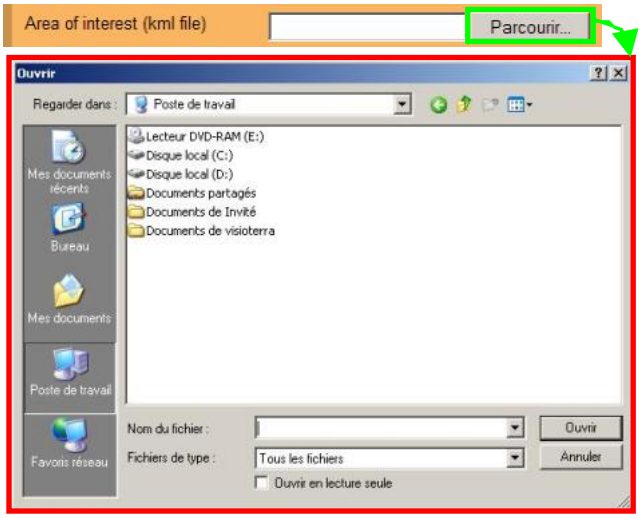
The first parameter to be set is the definition of the area of interest on which acquisitions have to be looked for. This parameter is mandatory.

Activating the "Browse" button displays an "Open" file chooser.

Areas of interest are closed polygons without holes stored in graphic files according to a specific format.

VTAOIWatcher recognizes only the KML format in input. KML stands for "Keyhole Markup Language", it is a format originally managed by Google Earth.

AOI may match complex patterns with an undefined number of vertices, with undefined extents on the Earth.



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2.1.2 Selection of the monitored period

Both start and stop dates of the watching period can be set. To select a starting or an ending date, one can either fill the text field using a YYYY-MM-DD date format, or press the calendar button and select a particular date.

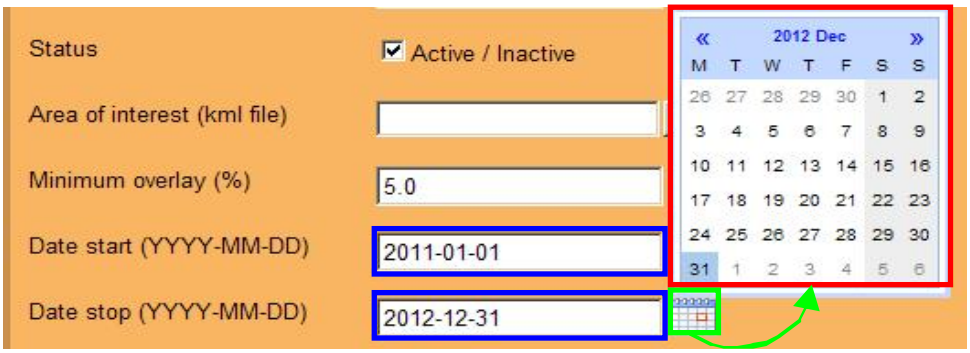

fig. 4– Setting the start and stop dates.

2.1.3 Choice of the Mission / Instrument / Mode(s)

User has also to define what type of data he/she wants to monitor by selecting a Mission / Instrument / Mode(s) (MIM). The available MIMs for this current version are all free data :

- Landsat-5 / TM that is an optic 7-bands instrument at 30 m GSD (ground samping distance),
- Landsat-7 / ETM+ / SLC-on that is an optic 8-bands instrument (30 m and 15 m GSD),
- Landsat-7 / ETM+ / SLC-off that is the previous one after the damage of the Scan Line Corrector occurred on the 31st May 2003,
- Envisat / ASAR / WSM being a 150 m GSD radar instrument with 400 km wide swath,
- Envisat / ASAR / IMM being a 150 m GSD radar instrument with 100 km wide swath.

To set a MIM for the monitored area, one has to click on the link " Add Mission/Instrument/mode". It adds new " Mission/Instrument/Mode" line where one can specify MIM and its associated processing sequence. Each time a new MIM is added, a new " Add Mission/Instrument/mode".is added below so that several MIMs can be added this way on a same monitored area

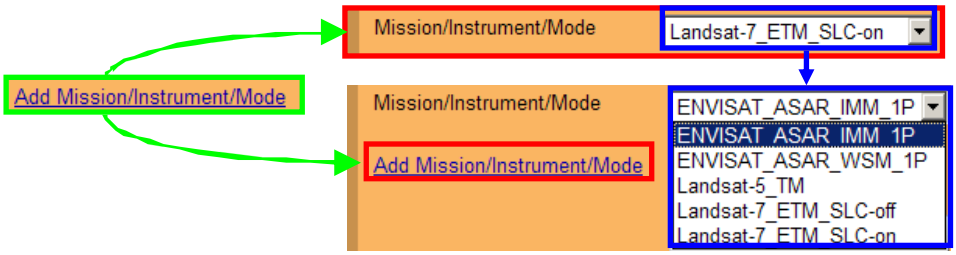

fig. 5- Selection of a MIM.

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2.1.4 Attribution of a processing sequence

Once the Mission / Instrument / Mode(s) (MIM) is selected, user has to choose how the raw data will be automatically processed. This is done by picking his choice among the items available in the scrolling menu.

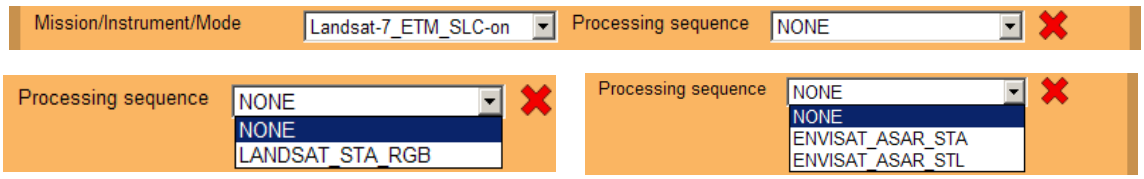

fig. 6- Choice of the processing sequence for the two MIM classes.

See A.2 for more details on the processing sequences.

2.1.5 Specification of a minimum overlay threshold

The overlay between an image and the AOI is defined as the fraction of the surface the AOI intersected by this image and the whole AOI surface. This ratio is expressed in percent.

To narrow the query result to the most pertinent images, a minimum overlay threshold must be specified in the "Minimum overlay" textfield. Any non-zero value will sort out images that do not intersect the AOI.

2.1.6 Choosing a name

A name must be given to the monitored area in the "Name" textfield.

2.1.7 Selecting the status

If a monitored area' status is "inactive", VTAOIWatcher watching process is left pending. Processed EO products can still be accessed but new updates won't be fired until the status hasn't changed to "active". In this case, process resumes where it was stopped.

A status is active if the checkbox "Status" is checked.

2.1.8 Saving the monitored area

The monitored area and its parameters can be saved when all fields are filled at least by the possible default value. User presses the "Save monitored area" button which opens a pop-up showing the save is successful.

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2.2 Automatic update of the query results

Once a monitored area has been saved, VTAOIWatcher will look for existing data fulfilling the request and will regularly check if new images fit in the criteria. Every image found this way is then processed according to the user's requirements, prepared for efficient visualisation and its products added to the monitored area existing "EO-products" in the local archive.

2.2.1 Automatic acquisition and update

Once the user has saved an active monitored area, VTAOIWatcher will look for archive data on the servers associated with the selected MIMs. Data that fits the query will be downloaded and then be processed along with selected processing sequence in the monitoread area. This process is no instantaneous, the user should not expect positive results in minutes.

Then, without any need of user's intervention, VTAOIWatcher will keep watching the different servers to check if new images match its monitored areas attributes. Hence, new EO-products will progressively be added to the existing ones.

This download only happens once and is asynchrone with the user's need so as to allow access to EO products at local download speed even when data is temporarly or definitly unavailable on the original remote server.

2.2.2 Processing sequence

After the download, EO products are processed and converted to standard file format like TIFF and/or KMZ. For example, the downloaded images are first geocoded in geographic coordinates on a WG484 ellipsoid to allow easy visualisation on a virtual globe, then the channels are separated in differents masks for clouds in optical or land and sea in radar. Then bands are stretched individually following instructions, either in local or in automatic stretching, and merged into a TIFF image available among EO-products.

Predefined processing sequenes are detailed in appendix A.2.

2.3 Viewing results

2.3.1 Viewing the AOI of the monitored area

User may access to a specific monitored area by selecting it in the "monitored areas" panel. Area of interest of this monitored area will be displayed in "VTGlobe" panel, which embed a Web mapping tool.

fig. 7- List and selection of a "Monitored area".

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2.3.2 Viewing the list of EO products of a monitored area

The list of processed EO products of a monitored area appears by clicking the "Properties" button.

The name of a EO Product follows the pattern :**MIM_Ts_Te_IPS** with:

- **MIM** the Mission/Instrument/Mode selected.
- **Ts** imaging "start time" and **Te** imaging "end time" written as YYYYMMDD_HHmmSS.
- **IPS** the image processing sequence's name.

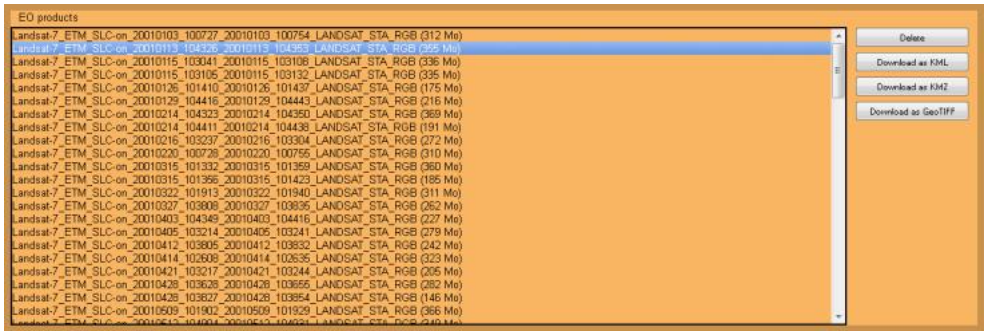

fig. 8- List of "EO products" for a particular "Monitored area".

2.3.3 Navigating across a EO product display

Each EO product may be viewed in "VTGlobe" panel by selecting it. User can pan and zoom EO product up to native resolution.

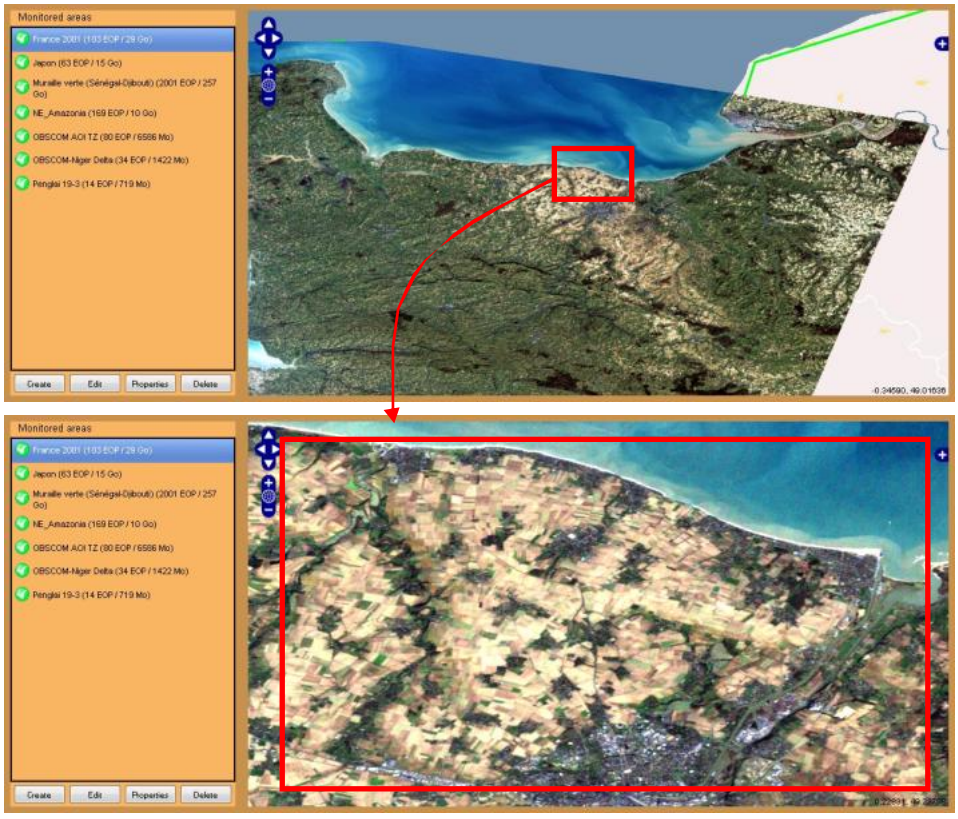

fig. 9 - Full resolution visualization (Landsat-7 ETM image).

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2.3.4 Managing EO products

Other options are available for EO products :

- Deleting, by pressing "Delete" button,
- Exporting to KML (small file with dynamic links), by pressing "Download as KML",
- Exporting to KMZ (heavy standalone file), by pressing "Download as KMZ",
- Exporting to GeoTIFF, by pressing "Download as GeoTIFF".

KML, KMZ and GeoTIFF files are in full resolution.

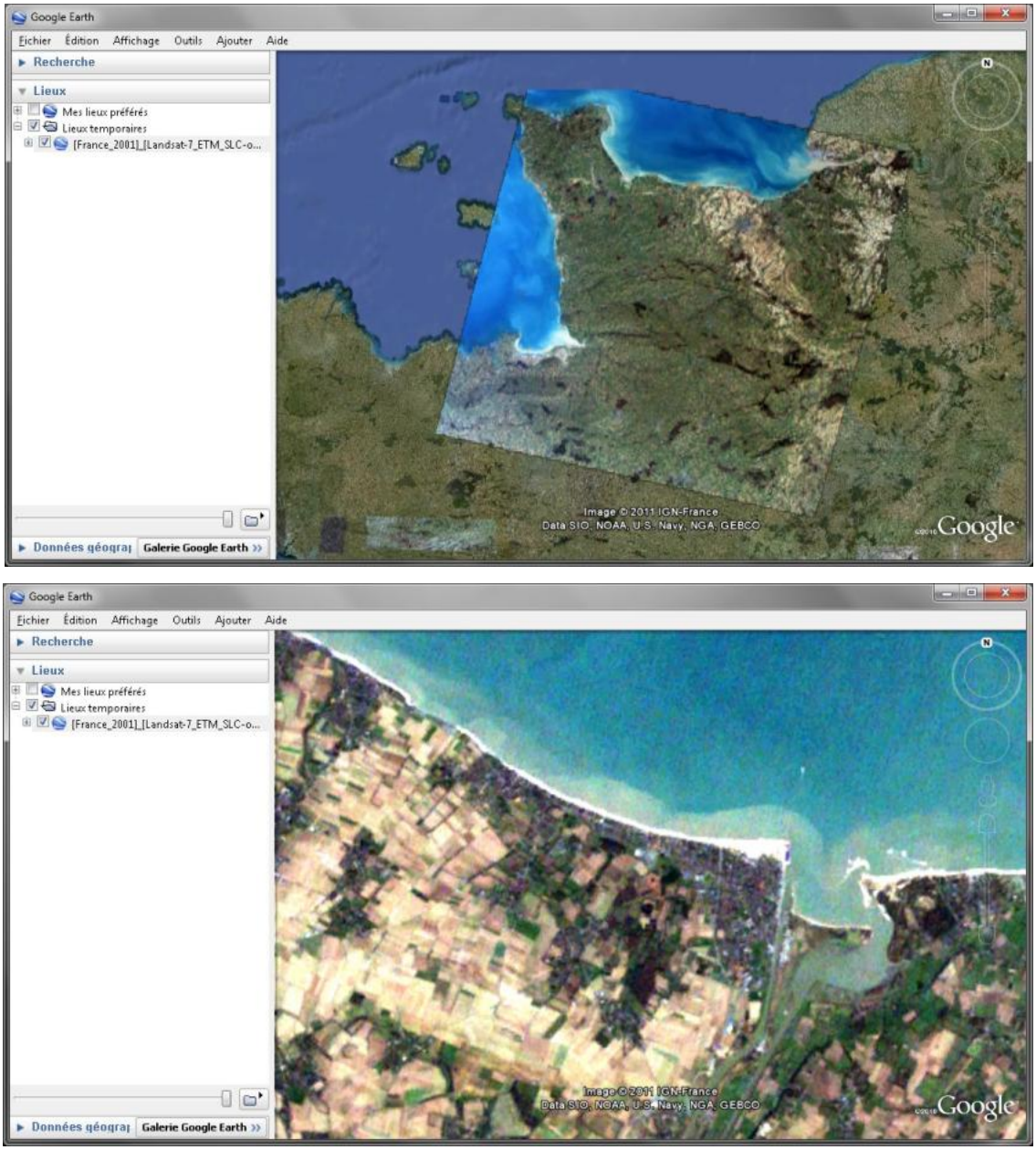

fig. 10 - KML visualization with Google Earth. Wide shot and Close-up views.

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2.4 Editing a monitored area

To edit a monitored area, the user has to choose the "Edit" button in the control panel. It opens the monitored area edition panel which is very similar to the monitored area creation panel.

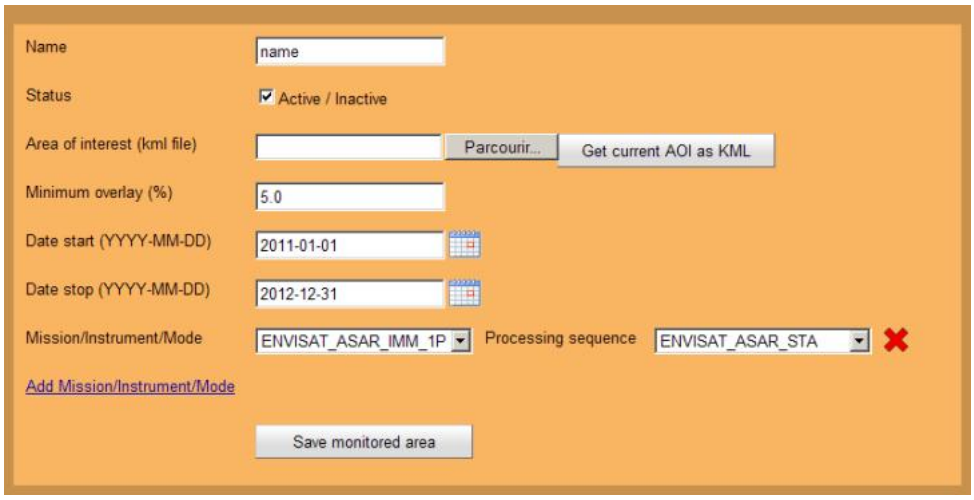

fig. 11 - Monitored area edition panel.

All parameters set in the creation process are accessible and editable the same way they were set at the creation. Area of interest can be downloaded by using the "Get current AOI as KML" button.

fig. 12 - Get Current AOI as KML button.

Once the edition of the monitored area is finished, pressing the "Save monitored area" button saves all changes.

2.5 Deleting data

A monitored area and all its EO products can be deleted with "Delete" button. A pop-up asks for confirmation and reminds eventual sub folders will be deleted as well.

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ANNEX A - PROCESSING SEQUENCES

A.1 Existing VT process

In order to process images, VTAOIWatcher uses a set of tools (acting as "processing unit") called "VTProcess".

A.1.1 VTImport – Reprojection / Clipping

VTImport imports images from their native projection to geographic projection. Horizontal / vertical ground sampling distance and Upper-left / Lower-right coordinates of output image can be set.

Command line :

```
C:\>java -jar VTImport.jar
help for VTImport :
-if [arg1] [arg2]    absolute paths of input files - Optional : no
-of [arg1] [arg2]    absolute paths of output files - Optional : no
-cha [arg1] [arg2]   id of the bands. String values - Optional : yes
-ul [lon] [lat]      longitude and latitude of upper left corner - Optional : yes
-lr [lon] [lat]      longitude and latitude of lower right corner - Optional : yes
-gsx [double value]  horizontal ground sampling distance, in degrees - Optional : yes
-gsy [double value]  vertical ground sampling distance, in degrees - Optional : yes
```

A.1.1.1 Clipping

The data processor provides UL and LR clipping parameters to limit reprojection to the intersection between the image and the AOI.

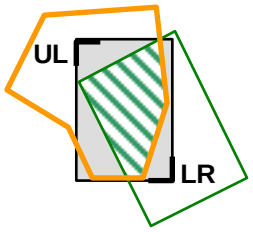

fig. 13– Clipping of an image.

A.1.1.2 Reprojection

The image is then reprojected from its native format to the geographic coordinates reference system. To this intent, for each output image picture, we look for the inverse image in the input image. If it doesn't belong to the input image, then it is a background pixel.

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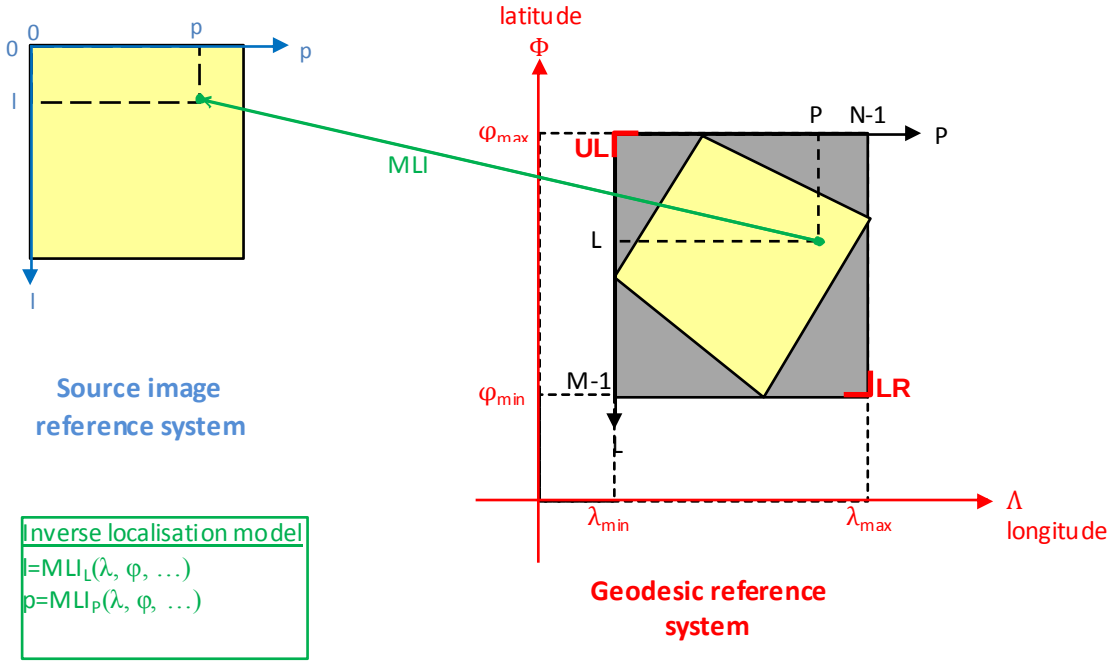

fig. 14– Geocoding scheme.

A.1.2 VTCloudMaskLandsat – Cloud detection

Clouds tend to show the brightest pixels of most images. Hence, they prevent an efficient stretching by saturating the bright part of the histogram while providing no interesting information to the user. Thus, the stretching process has to be preceded by a cloud removal step.

A.1.2.1 Radiance, reflectance and temperature calculation

Each pixel radiance, reflectance and temperature are calculated by the following formulas:

Radiance $$L_b = \left(\frac{LMAX_b - LMIN_b}{QCALMAX - QCALMIN} \right) \times (QCAL - QCALMIN) + LMIN_b$$

- **L_b** radiance value of a band b pixel.
- **$LMAX_b$** maximum value of radiance for band b.
- **$LMIN_b$** minimum value of radiance for band b.
- **QCALMAX** pixel maximum value (often 255)
- **QCALMIN** pixel minimum value (often 1)
- **QCAL** value of a band b pixel.

$LMAX_b$ et $LMIN_b$ are found in the Landsat metadata file.

Reflectance $$\rho_p = \frac{\pi \times L_\lambda \times d^2}{ESUN_\lambda \times \cos(\theta_s)}$$

- ρ_p reflectance value of a band p pixel.
- L_λ previously calculated radiance value of a pixel for the same band.
- d Sun - Earth distance in astronomical units.
- $ESUN_\lambda$ mean solar irradiance for this band, top of atmosphere.
- θ_s Sun zenital angle.

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d and $ESUN_\lambda$ values can be found in the *Landsat Handbook*, respectively in table 11.4 and 11.3 at the http://landsathandbook.gsfc.nasa.gov/handbook/handbook_htmls/chapter11/chapter11.html.

Temperature $T = \frac{K_2}{\ln\left(\frac{K_1}{L_\lambda}+1\right)}$

- T given pixel temperature.
- K1 and K2 constants given in *Landsat Handbook* in table 11.5.
- L_λ previously calculated radiance value of a pixel for the thermic band

A.1.2.2 Filters description

Complete algorithm for cloud detection is described in this paper:

Irish R.R., Barker J.L., Goward S.N., and Arvidson T., 2006. Characterization of the Landsat-7 ETM+ Automated Cloud-Cover Assessment (ACCA) Algorithm. Photogrammetric Engineering and Remote Sensing vol. 72(10): 1179-1188,

http://landsathandbook.gsfc.nasa.gov/pdfs/ACCA_Special_Issue_Final.pdf.

A.1.3 VTMask

VTMask marks pixels as background in an input image by using a mask image. For example, this allows to separate sea and land or cloud and not cloud with an appropriate mask.

Command line:

```
C:\>java -jar VTMask.jar
help for VTMask :
-if [arg1] [arg2]  absolute paths of input files - Optional : no
-msk [arg]         absolute path of mask file - Optional : no
-of0 [arg1] [arg2] absolute paths of output files in which only are kept the pixels
                   having a zero value in the mask image - Optional : yes
-of1 [arg1] [arg2] absolute paths of output files in which only are kept the pixels
                   having a non-zero value in the mask image - Optional : yes
```

A.1.4 VTStretAuto – Automatic stretching

VTStretAuto applies a stretching depending on a saturation threshold and histogram of the image.

Command line:

```
C:\>java -jar VTStretAuto.jar
help for VTSretAuto :
-if [arg1] [arg2]  absolute paths of input files - Optional : no
-of [arg1] [arg2]  absolute paths of output files - Optional : no
-sat [arg]         This ratio gives the relative number of pixels that will be set to 0
                   on the left of histogram. This ratio will also be used to set to the
                   maximum (255 for 8-bit/pixel) on the right of the histogram. Default
                   value is 0.005. - Optional : yes
-odd [arg]         output data depth in bits. Will be 8 or 16. Default value is same as
                   input. - Optional : yes
```

A.1.5 VTStretLocal – Local Stretching

VTStretLocal applies a stretching on each pixel depending on the statistics of neighbouring pixels.

Command line:

```
C:\>java -jar VTStretLocal.jar
```

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```
help for VTStretLocal :
-if [arg1] [arg2]  absolute paths of input files - Optional : no
-of [arg1] [arg2]  absolute paths of output files - Optional : no
-mea [arg]         The desired mean in output enables the control of the brighness of
                   each band in output. Default value is 128 - Optional : yes
-std [arg]         The desired standard deviation in output enables the control of the
                   contrast of each band in output. Default value is 50. - Optional :
                   yes
-sws [arg]         The -sws parameter specifies the size of the slicing window in wich
                   local statistics have to be computed. This parameter is a strictly
                   positive integer with generally a large value (for exemple 601). To
                   avoid bioses, the -sws value should be always odd. Default value is
                   301. - Optional : yes
-odd [arg]         output data depth in bits. Will be 8 or 16. Default value is same as
                   input. - Optional : yes
```

A.1.6 VTCompose – Merging

VTCompose merges two images in one, setting non background pixels of first image in the output image and pixels of second image for background pixels of the first image.

Command line :

```
C:\>java -jar VTCompose.jar
help for VTCompose :
-if [arg1] [arg2]  absolute paths of input files - Optional : no
-of [arg1] [arg2]  absolute paths of output files - Optional : no
```

A.1.7 VTComposeRGB – RGB Merging

VTComposeRGB merges three mono-channel images into one RGB image.

Command line :

```
C:\>java -jar VTComposeRGB.jar
help for VTComposeRGB :
-if [red] [green] [blue] absolute paths of red, green, blue input raster - Optional : no
-of [arg1] [arg2]        absolute paths of output files - Optional : no
```

A.1.8 VTExportKMZ – "Super overlay" KMZ exporting

Exports input image to Google Earth file format using the "super overlay" representation. Input image is subsampled several times, depending on image dimension and each map is cut into small tiles, for example 256 x 256 pixels. Tiles are encoded to the non destructive PNG image format which supports alpha channel.

This structure allows Google Earth to display only the tiles adapted to current view.

Command line :

```
C:\>java -jar VTExportKMZ.jar
help for VTExportKMZ :
-if [arg1] [arg2]  absolute paths of input files - Optional : no
-of [arg1] [arg2]  absolute paths of output files - Optional : no
-siz [max size]    if specified, max size of output file, in bytes. - Optional : yes
-l [level number]  if specified, max level count in KMZ archive - Optional : yes
```

A.1.9 VTDelete

Delete files denoted by pathname. Useful for temporary files or directories.

Command line :

```
C:\>java -jar VTDelete.jar
help for VTDelete :
-if [arg1] [arg2]  absolute paths of input files - Optional : no
```

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A.2 Existing processing sequences

A.2.1 ENVISAT_ASAR_STA

A.2.1.1 Scope

The goal of this processing sequence is to maximize the image contrast while keeping the original radiometry distribution.

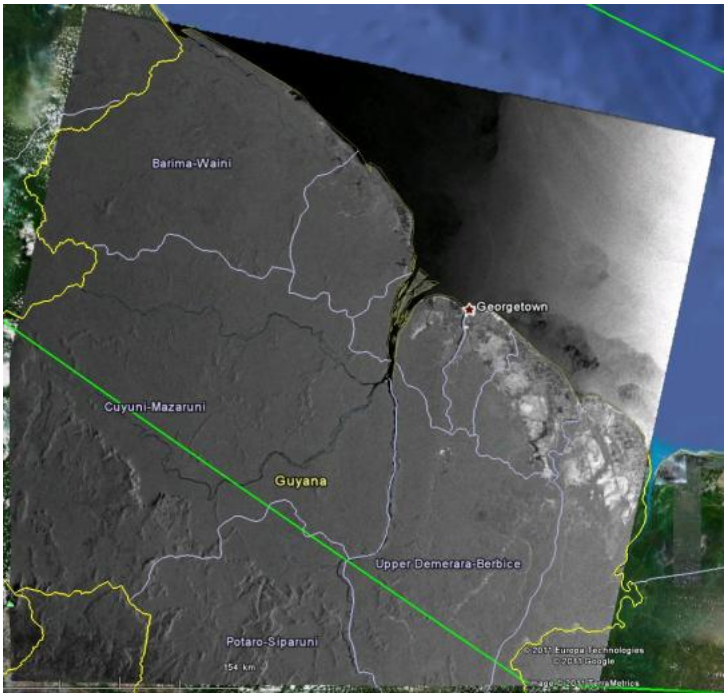

fig. 15- ENVISAT_ASAR_STA processed image example

A.2.1.2 Input products

The products allowed to use this processing sequence obey the following MIM format :

- Envisat / ASAR / WSM
- Envisat / ASAR / IMM

A.2.1.3 Output data

The output files are named :

- “imp.sta.tif”, a full resolution processed data
- “imp.sta.kmz”, the same as the previous but in multiscale Google Earth format
- “imp.sta.quicklook.kmz”, a coarse resolution quick-look of the image.

A.2.1.4 Processing sequence

VTImport :

- Reproject from native to geographic projection
- Clip to bounding box of intersection between AOI and image footprint

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- Use native ground sampling distance

VTStretAuto :

- 16bits/pixels to 8bits/pixel conversion
- Automatic stretching with value of 2%

VTExportKMZ : Create a KMZ from full resolution image

VTExportKMZ : Create a KMZ from quick-look

VTDelete : delete temporary files

Script :

```
java -Xmx1024M -jar $BIN_DIR$/VTImport.jar -if $EOP$ -of imp $CLIP$
java -Xmx1024M -jar $BIN_DIR$/VTStretAuto.jar -if imp -of imp.sta.tif -odd 8 -sat 0.02
java -Xmx1024M -jar $BIN_DIR$/VTExportKMZ.jar -if imp.sta.tif -of imp.sta.kmz
java -Xmx1024M -jar $BIN_DIR$/VTExportKMZ.jar -l 2 -if imp.sta.tif
     -of imp.sta.quicklook.kmz
java -jar $BIN_DIR$/VTDelete.jar -if imp
```

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A.2.2 ENVISAT_ASAR_STL

A.2.2.1 Scope

The goal of this processing sequence is to provide homogeneous data on the land and on the sea parts of the image so that each part respects locally A given statistical distribution model with an uniform mean and standard deviation. No matter the imaging conditions and the elements pictured on the image, all output files will look homogeneous with regard to the other EO products that have been processed in the same way.

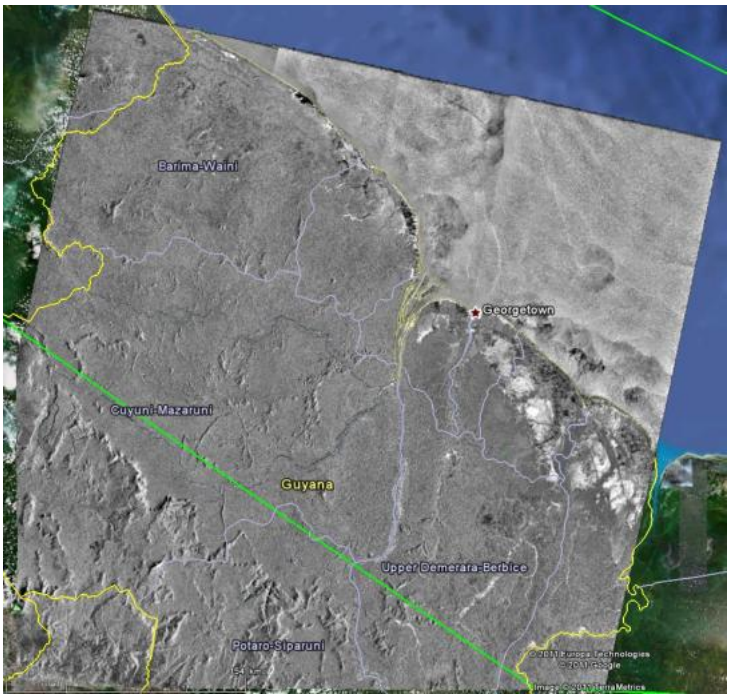

fig. 16- ENVISAT_ASAR_STL processed image example

A.2.2.2 Input products

The products allowed to use this processing sequence obey the following MIM format :

- Envisat / ASAR / WSM
- Envisat / ASAR / IMM

A.2.2.3 Output data

The output files are named :

- “imp.stl.com.tif”, a full resolution processed data
- “imp.stl.com.kmz”, the same as the previous but in multiscale format and virtual globe compatible
- “imp.stl.com.quicklook.kmz”, a coarse resolution quicklook of the previous

A.2.2.4 Processing sequence

VTImport :

- Reproject from native to geographic projection
- Clip to bounding box of intersection between AOI and image footprint

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- Use native ground sampling distance

VTMask : Separate land and sea

VTStretLocal (land):

- 16bits/pixels to 8bits/pixel conversion
- Apply local stretching with mean=128, standard deviation=60, statistical windows size=901

VTStretLocal (sea):

- 16bits/pixels to 8bits/pixel conversion
- Apply local stretching with mean=160, standard deviation=60, statistical windows size=301

VTCompose : merge land and sea images

VTExportKMZ : Create a KMZ from full resolution image

VTExportKMZ : Create a KMZ from quicklook

VTDelete : delete temporary files

Script :

```
java -Xmx1024M -jar $BIN_DIR$/VTImport.jar -if $EOP$ -of imp $CLIP$
java -Xmx1024M -jar $BIN_DIR$/VTMask.jar -if imp
     -msk $BIN_DIR$/LandSeaMask/LandSeaMask.vtCollection -of0 imp.sea -of1 imp.land
java -Xmx1024M -jar $BIN_DIR$/VTStretLocal.jar -if imp.sea -of imp.sea.stl -odd 8
     -mea 160 -std 60 -sws 301
java -Xmx1024M -jar $BIN_DIR$/VTStretLocal.jar -if imp.land -of imp.land.stl -odd 8
     -mea 128 -std 60 -sws 901
java -Xmx1024M -jar $BIN_DIR$/VTCompose.jar -if imp.land.stl imp.sea.stl
     -of imp.stl.com.tif
java -Xmx1024M -jar $BIN_DIR$/VTExportKMZ.jar -if imp.stl.com.tif -of imp.stl.com.kmz
java -Xmx1024M -jar $BIN_DIR$/VTExportKMZ.jar -l 2 -if imp.stl.com.tif
     -of imp.stl.com.quicklook.kmz
java -jar $BIN_DIR$/VTDelete.jar -if imp imp.sea imp.land imp.sea.stl imp.land.stl
```

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A.2.3 LANDSAT_STA_RGB

A.2.3.1 Scope

The goal of this processing sequence is to provide images close to true-colour but as contrasted as possible on each of the three bands.

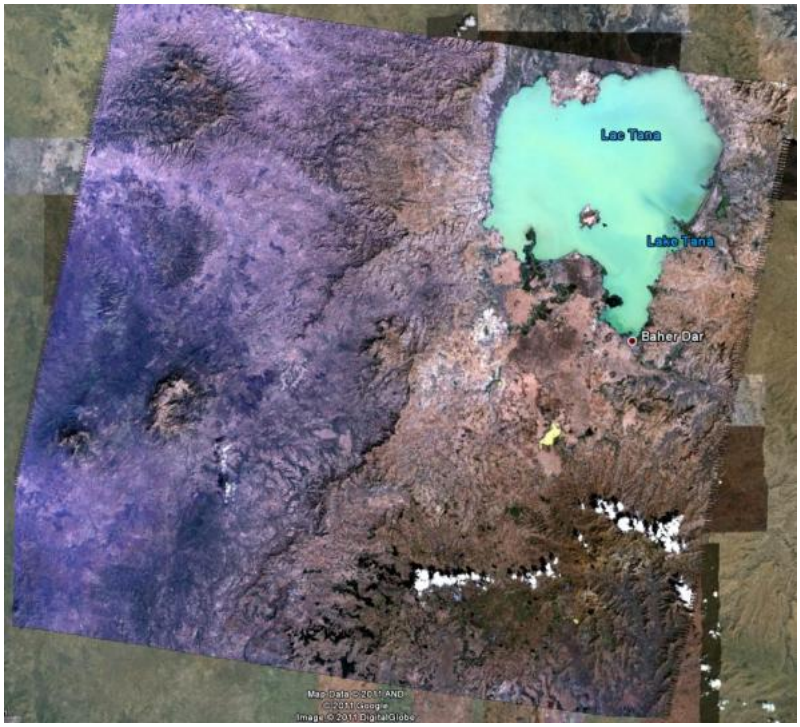

fig. 17 - LANDSAT_STA_RGB processed image example

A.2.3.2 Input products

The products allowed to use this processing sequence obey the following MIM format :

- Landsat-5 / TM
- Landsat-7 / ETM+ / SLC-on
- Landsat-7 / ETM+ / SLC-off

A.2.3.3 Output data

The output files are named :

- "imp.sta.com.tif", a full resolution processed data
- "imp.sta.com.kmz", the same as the previous but in multiscale format and virtual globe compatible
- "imp.sta.com.quicklook.kmz", a coarse resolution quicklook of the previous

A.2.3.4 Processing sequence

VTImport :

- Reproject band 1,2,3 (blue, green, red) from native to geographic projection
- Clip to bounding box of intersection between AOI and image footprint
- Use native ground sampling distance

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VTStretAuto : Automatic stretching with value of 2% on each band

VTComposeRGB : merge three band into RGB images

VTExportKMZ : Create a KMZ from full resolution image

VTExportKMZ : Create a KMZ from quicklook

VTDelete : delete temporary files

Script :

```
java -Xmx1024M -jar $BIN_DIR$/VTImport.jar -if $EOP$ -of imp.1 imp.2 imp.3 $CLIP$ -cha 1
     2 3
java -Xmx1024M -jar $BIN_DIR$/VTStretAuto.jar -if imp.1 imp.2 imp.3 -of imp.sta.1
     imp.sta.2 imp.sta.3 -odd 8 -sat 0.02
java -Xmx1024M -jar $BIN_DIR$/VTComposeRGB.jar -if imp.sta.3 imp.sta.2 imp.sta.1 -of
     imp.sta.com.tif
java -Xmx1024M -jar $BIN_DIR$/VTExportKMZ.jar -if imp.sta.com.tif -of imp.sta.com.kmz
java -Xmx1024M -jar $BIN_DIR$/VTExportKMZ.jar -l 2 -if imp.sta.com.tif -of
     imp.sta.com.quicklook.kmz
java -jar $BIN_DIR$/VTDelete.jar -if imp.1 imp.2 imp.3
java -jar $BIN_DIR$/VTDelete.jar -if imp.sta.1 imp.sta.2 imp.sta.3
```

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